Babylon University **Third Stage**
College of Medicine **Lecture 1**
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Pathology of Heart

Ischemic Heart Disease (IHD)

Ischemic heart disease (IHD) is the leading cause of death worldwide for both men and women (7 million total per year).

IHD is the generic designation for a group of pathophysiologically related syndromes resulting from myocardial ischemia.

IHD usually presents as one or more of the following clinical syndromes:

- **Myocardial infarction.**
- **Angina pectoris.**
- **Chronic IHD with heart failure.**
- **Sudden cardiac death.**

Causes of myocardial ischemia:

1 - Reduced blood flow due to obstructive atherosclerotic lesions in the coronary arteries (90% of cases).

2 - Coronary emboli with blockage of small myocardial blood vessels.

3 - Lowered systemic blood pressure (e.g., shock).

4 - Diminished availability of blood or oxygen due to shock, or by hypoxemia.

5 - Tachycardia increases oxygen demand (because of more contractions per unit time) and decreases supply (by decreasing the relative time spent in diastole, when cardiac perfusion occurs).

Epidemiology.

IHD in its various forms is the leading cause of death for both males and females in the United States and other industrialized nations, each year nearly 500,000 Americans die of IHD.

However, the overall death rate from IHD has fallen in the United States by approximately 50%, this remarkable improvement has resulted primarily from

(1) Prevention, achieved by modification of important risk factors, such as smoking, elevated blood cholesterol, and hypertension.

(2) diagnostic and therapeutic advances, allowing earlier, more effective, and safer treatments(new medications, coronary care units, thrombolysis for MI, percutaneous transluminal coronary angioplasty, endovascular stents, coronary artery bypass graft (CABG) surgery, and improved control of heart failure and arrhythmias).

Additional risk reduction may potentially be achieved by maintenance of normal blood glucose levels in diabetic patients, control of obesity, and prophylactic anticoagulation of middle-aged men with aspirin.

<u>Pathogenesis of ischemic heart disease.</u>

The dominant cause of the IHD syndromes is insufficient coronary perfusion relative to myocardial demand, due to chronic, progressive atherosclerotic narrowing of the coronary arteries, and variable degrees of superimposed acute plaque change, thrombosis, and vasospasm.

Chronic Atherosclerosis

Progressive narrowing of the lumen leading to stenosis ("fixed" obstructions) which compromise blood flow, a fixed lesion obstructing 75% or greater of the lumen is generally required to cause symptomatic ischemia precipitated by exercise (most often manifested as chest pain, known as angina); obstruction of 90% of the lumen can lead to inadequate coronary blood flow even at rest.

Acute Plaque Change

The acute coronary syndromes are typically initiated by an unpredictable and abrupt conversion of a stable atherosclerotic plaque to an unstable and potentially life-threatening atherothrombotic lesion through rupture, superficial erosion, ulceration, fissuring, or deep hemorrhage, in most instances, the plaque change causes the formation of a superimposed thrombus that partially or completely occludes the affected artery.

<u>Angina Pectoris</u>

Angina pectoris (literally, chest pain) is characterized by paroxysmal and usually recurrent attacks of substernal or precordial chest discomfort (variously described as constricting, squeezing, choking, or knifelike) caused by transient myocardial ischemia.

The three overlapping patterns of angina pectoris—(1) stable or typical angina, (2) Prinzmetal variant angina, and (3) unstable or crescendo angina

Angina is caused by varying combinations of increased myocardial demand, decreased myocardial perfusion, and coronary arterial pathology, however, not all ischemic events are perceived by patients (silent ischemia).

Myocardial Infarction

MI, also known as "heart attack," is the death of cardiac muscle due to prolonged severe ischemia. It is by far the most important form of IHD. About 1.5 million individuals in the United States suffer an MI annually.

Incidence and Risk Factors

MI can occur at any age, but its frequency rises progressively with increasing age. Nearly 10% of myocardial infarcts occur in people under age 40, blacks and whites are equally affected, men are at significantly greater risk than women, women are protected against MI and other heart diseases during the reproductive years. However, the decrease of estrogen following menopause is associated with rapid development of coronary artery disease, and IHD is the most common cause of death in elderly women.

Pathogenesis of myocardial infarction.

In the typical case of MI, the following sequence of events is considered most likely

- **Sudden change in an atheromatous plaque.**
- **Platelets adhere, become activated, release their granule contents, and aggregate to form microthrombi.**
- **Vasospasm is stimulated by mediators released from platelets.**
- **Tissue factor activates the coagulation pathway.**
- **Frequently within minutes, the thrombus evolves to completely occlude the lumen of the vessel.**

In approximately 10% of cases, transmural MI occurs in the absence of the typical coronary vascular pathology. In such situations, other mechanisms may be responsible for the reduced coronary blood flow, including:

- **Vasospasm.**
- **Emboli.**
- **Ischemia without detectable coronary atherosclerosis and thrombosis may be caused by disorders of small intramural coronary vessels, such as vasculitis.**

Subendocardial Infarction

Most myocardial infarcts are transmural, in which the ischemic necrosis involves the full or nearly full thickness of the ventricular wall, in contrast, a subendocardial (nontransmural) infarct constitutes an area of ischemic necrosis limited to the inner one third to one half of the ventricular wall. As the subendocardial zone is normally the least perfused region of myocardium, this area is most vulnerable to any reduction in coronary flow. A subendocardial infarct can occur as a result of a plaque disruption followed by a coronary thrombus that becomes lysed before myocardial necrosis extends across the full thickness of the wall.

However, subendocardial infarcts can also result from prolonged, severe reduction in systemic blood pressure, as in shock superimposed on chronic, otherwise noncritical, coronary stenoses.

Transmural infarcts are often referred to as "ST elevation infarcts" and subendocardial infarcts are known as "non-ST elevation infarcts."

Morphology of MI

The gross and microscopic appearance of an infarct depends on the duration of survival of the patient following the MI.

The gross features:

Early recognition of acute MI can be difficult, particularly when death has occurred within a few hours after the onset of symptoms.

MIs less than 12 hours old are usually not apparent on gross examination.

By 12 to 24 hours an infarct can be identified grossly in transverse slices as a reddish-blue area of discoloration.

Thereafter, the infarct becomes progressively more sharply defined, yellow-tan, and soft.

By 10 days to 2 weeks, it is rimmed by a hyperemic zone.

Over the succeeding weeks (2-8 weeks), the injured region evolves to a fibrous scar.

The histopathologic changes:

0–4 hr. (None)

4–12 hr. (edema, hemorrhage)

12–24 hr. (pyknosis, “waviness”)

24 hr. -4 days (neutrophils)

7 days (macrophages)

2-8 Weeks (organization)

> 2 Months (fibrosis)

Once a lesion is completely healed, it is impossible to determine its age (i.e., the dense fibrous scar of 8-week-old and 10-year-old infarcts may look identical).

<u>Clinical Features</u>

MI is diagnosed by:

1 - *Clinical symptoms*: Patients with MI often present with a rapid, weak pulse and profuse sweating, dyspnea due to impaired contractility of the ischemic myocardium and the resultant pulmonary congestion and edema.
However, in about 10% to 15% of patients the onset is entirely asymptomatic and the disease is discovered only by electrocardiographic changes or laboratory tests that show evidence of myocardial damage, such “silent” MIs are particularly common in elderly patients and in the setting of diabetes mellitus.

2 - *Laboratory tests for the presence of myocardial proteins in the plasma*: The laboratory evaluation of MI is based on measuring the blood levels of proteins that leak out of fatally injured myocytes; these molecules include myoglobin, cardiac troponins T and I, the MB fraction of creatine kinase (CK-MB), lactate dehydrogenase.

3 - *Characteristic electrocardiographic changes*.

<u>Consequences and Complications of MI</u>

- **Contractile dysfunction.**
- **Arrhythmias.**
- **Myocardial rupture.**
- **Pericarditis.**
- **Infarct extension.**
- **Mural thrombus.**
- **Ventricular aneurysm.**
- **Papillary muscle dysfunction.**
- **Progressive late heart failure (chronic IHD).**

The risk of specific postinfarct complications and the prognosis depend primarily on the infarct size, location, and thickness (subendocardial or transmural).